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THE STUDY OF EXPERIMENTAL PEDAGOGY IN GERMANY

SECOND ARTICLE¹

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The first group of experimental pedagogical investigations deals with the formal side of school instruction. Ought instruction to be given in full-hour lessons or in shorter ones? That is to say, should there be an intermission between the recitations? In what order are the easier and more difficult studies to be distributed over the school day, and which studies are after all to be called difficult? How much time should be used in daily instruction, and is it advisable to extend the work into the free time of the pupil by giving him oral and written tasks for home-work?

These questions came up at the moment when people learned to look upon the mental activity of the pupil as an expenditure of energy, of psycho-physical force. The latter thought is a new and important idea, by means of which modern pedagogy enlarges in a humane way its didactic principles of instruction.

As is well known, the pupil was in former years considered a mere receptacle for all kinds of knowledge. Modern instruction, on the contrary, tries to develop in the most intensive way the self-activity of the pupil. The manifold processes of the pupil's perception, apperception, and judgment must support and penetrate each other. The teacher's question must not only draw upon the memory, but it must arouse and set these mental processes free. In this sense one teaches today in a way which develops, and in this consists the art of the teacher.

Let us turn now to the pupil. It is impossible for him to arouse this logical activity out of nothing. Every mind which is mentally active is at work. It expends psychical energy.

¹ The first article in this series appeared in the *School Review*, January, 1907.

Psychical energy when concentrated becomes attention. Every logical activity presupposes that its object is grasped by means of attention. Let us take an example: Mental activity, with its living organization of perception, presentation, and thought, is like the machinery of a mill in which many wheels work ingeniously into each other. This machinery has to be driven by a brook. To be put in motion and to continue in motion it needs only the force of the water. If the activities, perception, presentation, and thought are to work into each other, they need also a source of power. The brook which drives this mental machinery is the psychical energy of attention.

Our example shows how important the pedagogical treatment of attention is. This is the psychical reservoir of energy by which the pupil does all his mental work. This capital should neither be neglected nor wasted by the teacher. It should be used in such a way that instruction may produce the greatest effect while expending as little as possible of that energy. Therefore to the demand that instruction shall arouse this mental activity is added the demand for economy. With this idea of an instruction which elicits and strengthens mental activity, thought out with insight of genius by the great pedagogues of the past century, our century combines the ideas of social hygiene and humanity. Since stimulating instruction expends the mental strength of the pupil most intensively, it must be economical. Economical of what? of the psychical energy of the pupil which the teacher arouses in the form of attention. *Why economical?* Nowhere in the world can work be done without expending something. In our case the nervous force of the pupil is used up. To be more exact, the nerves are overloaded with worn-out particles; toxins, poisonous materials, causing fatigue, are created which prevent further activity of the nerves. Consequently it becomes a hygienic duty of the teacher to handle the capital of psychical energy as economically as possible.

I have compared the psychical energy to the force of a brook. As the level of every brook changes with the season, so the degree of psychical energy is different at different hours. The first

thing which the psychological teacher must know is when that source of strength flows more fully and when more sparingly. It is a fact that the quantity of it which the pupil controls, and which in given cases he must put into the concentrated form of attention, is subject to daily and yearly changes. And the teacher must neglect neither the daily nor the yearly fluctuations of psychical energy.

In order to be able to know the amount of psychical energy at every moment, one must be able to measure it at every moment. Measuring is the most important business of the experimental psychologist. Measure and number make him master of the world of consciousness, as measure and number made the physicist master of the material world. Now, one can never measure without a unit of measurement; therefore it is most important to acquire some method of expressing numerically the different psychical activities. Upon this task the most ardent efforts, the best art, of the experimental psychologist is directed. Often it has happened that a method of measurement offered itself seductively which on close examination proved insufficient, so that the experimenter was forced to renewed consideration and new trials. The history of psychological methods of measuring is the history of human patience, but also of scientific victories.

W. Stern, *Privatdozent* in Breslau, has suggested a very convenient and useful method for measuring the momentary states of physical energy, and W. A. Lay, *Seminarlehrer* in Karlsruhe, has employed the method extensively. They perceived that every person seemed to have his own psychical tempo. Whoever listens to a lecture, sees gymnastic exercises, or does them himself, plays the piano with somebody else, sings, or debates; notices soon whether the tempo of the impressions is agreeable to him or not. Everyone left to himself chooses in speaking, walking, singing, writing, etc., a tempo which is natural to him. In the same manner one person counts, adds, multiplies, reads more quickly, the other one more slowly. That is to say, thinking has with different persons a definite tempo. In the laboratory of Professor Kraepelin at Heidelberg this

tempo has been studied in such different occupations as counting, writing, and adding. In doing so it was found that the tempo remained independent of the special kind of activity. He who adds slowly counts and writes slowly. He who adds quickly keeps this quick tempo in writing and counting. Thus it seems to be an expression of the present actual amount of stored-up energy.²

This conclusion is strengthened if we learn that the psychical tempo changes quite naturally in the course of a day. In such a change the changing state of psychic energy shows itself, and thereby a very simple method of measuring psychical energy is indicated. It is only necessary to count how often the child beats rhythmically three-four time at the rate best suited to him, in order to measure by the number of those beats the actual state of psychical energy. The more beats in a minute, the shorter consequently the duration of the measure, the more strongly psychical energy flows in the person. The fewer beats, the longer the measure, the lower the level of psychic energy. In short, beating time measures energy as the thermometer measures temperature.

The above-mentioned method of examining is excellent because it measures psychical energy without expending it, because it is short, because it can take place without preparation at any moment. If it is employed at different times of the day, the tempo in which an individual beats three-four rhythm from hour to hour will be an exact reflection of the course of his mental energy. We can read it from the curve, in which the hours of the day are the abscissas, and the durations of the measures are the ordinates.

In the main this curve keeps the same shape always, no matter what the mental or physical occupation happens to be which the experiment of time-beating interrupts. It is always the same characteristic M.-curve,³ no matter whether we deal with school or vacation days. According to Lay's school experiments, the different subjects of instruction or the intermissions

² W. A. Lay, *Experimentale Didaktik*.

³ W. Stern, *Psychologie der individueller Differenzen*.

between the recitations likewise cannot retard the wavelike motion. These influences work more or less upon the rising or falling of the curve of energy, but not upon its shape. Immediately after awakening psychic life flows rather slowly, and reaches only quite gradually during the hours of the forenoon (10-12) the maximum display of energy. Toward noon the curve sinks, and reaches one or two hours after dinner its minimum of the day, which, however, does not stand so low as the morning or evening minimum. The later afternoon (5-7) brings a second maximum, and the evening a third minimum.

The way in which energy varies should set us to thinking. At present we try in the German schools more and more to put all "scientific" subjects into the forenoon (7-1 o'clock in summer, 8-1 o'clock in winter), while the afternoon remains as free as possible, or is only reserved for technical subjects (drawing, gymnastics, singing). Here it is presupposed that the customary regular afternoon instruction from 2-4 o'clock is of very little use to the pupils, because they are still under the effects of digestion and not ready for special mental efforts.

It is indeed true that the teaching from 2-4 o'clock in the afternoon is not worth a great deal. But if we examine W. A. Lay's statistical tables, we find that psychical energy about 9-10 or 12-1 o'clock in the forenoon does not stand any higher.⁴ Moreover, W. A. Lay's tested persons were under specially favorable conditions, for the time from 12-12:30. The people investigated by Lay were pedagogical students of the "Karlsruher Internat" from seventeen to nineteen years of age, who had to rise at 5 o'clock and were being taught from 8-12 in the forenoon (dinner at 12:30) and from 2-5 in the afternoon. They were therefore free from 12 to 12:30 and had been under instruction only four hours. The pupils of schools in which the principle of forenoon instruction is carried out have had by this time already five hours of teaching, and they are still being taught at that time. Their mental energy between 12 and 1 might stand still lower than that of Lay's people between 2 and 4. It is therefore all the more difficult to understand why the au-

⁴ In Germany people dine at 1 o'clock.

thorities do not put the later school-hours into the afternoon from 4 to 6 or 5 to 7—hours worth so much more because then psychical energy reaches its second maximum—instead of working the brains of the already tired pupils from 12 to 1 o'clock. But when people planned the continued forenoon teaching, they had no thought of measuring psychical energy. They considered more the fact that the closing of school at 12 o'clock and beginning at 2 o'clock was a hardship to the pupils of larger cities. Here time spent in going to school is from 20 to 40 minutes. They must go back and forth during the recess from 12 to 2 o'clock, and besides find time to eat dinner. But must this hardship be replaced by a new one which, by piling up school-hours, causes the pupils to be victims again?

Psychical energy not only shows hourly and daily fluctuations, but peculiar to it are many other smaller and larger oscillations. The smallest ones are those well-known rhythmical risings and fallings of attention which occupy only seconds. It is impossible for anyone to be always attentive in the same degree. At one moment intense, at the next moment it yields a little, to concentrate again immediately afterward. If the question of the teacher strikes the pupil at the moment in which his attention is, so to speak, "not fixed," the prompt answer will easily fail. "You are asleep," says the teacher perhaps, and turns to another pupil. I wonder if the first pupil would not have known the right answer the next minute?

More striking are the yearly fluctuations of psychical energy. They follow the course of a W. W. A. Lay found that the psychical energy of his pupils declines from March to July, then grows up to September, thence to decline again. In March (the molting season of animals) it reaches its highest, in July and October its lowest state. What, according to this, is there to be said about the plan of the South German schools that put the decisive promotional examinations as well as the *Abiturientenexamen* into July—the time of the lowest state of psychical energy! [and what as to college-entrance examinations in June in America!—EDITOR.] On July 21, 1905, a pupil of *Obersekunda* from Stuttgart, who had to pass his promotional examinations to

Unterprima, wrote to me: "In the afternoon we had to do the hardest work. At 24° Réaumur we had to translate an exceedingly difficult piece of Greek. We were all sitting in our shirt-sleeves, had red faces, and between the rustling of the paper we heard the suppressed breathing of hard thinking." In the universities, too, is the hint of nature neglected. There professors hold their lectures and the students listen to them all during July. At the end one feels, according to the significant expression, *semesterkrank*. The North German schools dispose much more rationally of the time of the lowest state of psychic energy. Here students have vacations in July and October. This example should be followed by all other educational institutions.

We know now when the source of psychical energy flows. By means of this we do all mental work. Let us see now how it works; that is to say, how that state of intense attention works into which "teaching that develops mental activity" puts the pupil. In this state the pupil thinks logically. The working energy spends nervous force. The more nervous force used without giving the brain time to replace the poisonous waste-material, the more weariness shows itself. The toxin spreads out over the nervous system, and the consequence is that it becomes more and more useless in all its functions.

From this study of the indications of fatigue it follows that not only the sensory, but also the motor as well as the vaso-motor, effects of the nerves are being diminished. The decaying products are carried by the blood into all the nerve-tracts. Numerous experiments have confirmed this conclusion. Griesbach has shown that intellectual activity diminishes the sensation of difference in the senses. Mosso has proved that under the same conditions the power of the muscles—that is to say, the functional activity of the motor-nerves—is diminished likewise. Meumann found that after one of his pupils had worked at addition for two or three hours, the pressure of the blood was so greatly reduced that one could almost speak of heart weakness.

The just-named statement contradicts a widespread view. How frequently are people working with their minds told by people doing manual labor that their activity is not real work,

because it does not fatigue the body! And, on the other hand, there are still teachers who like to put between a few hours of hard mental labor gymnastics, singing, drawing, as "recreation lessons," with the idea that during such mainly motor occupations the mental freshness of the pupils will be renewed. This is entirely wrong. Since our nervous system is one complete whole, real fatigue will be felt at the same time in all fields of our activity. Bodily fatigue diminishes just as much mental force as mental work influences the strength of the muscles and the vaso-motor functions.

Fatigue through mental (or bodily) work shows itself not a little in the resulting work. Quality is poor, quantity diminishes; the time for recognition and association is prolonged, memory is weakened; capacity for exercise sinks; thoughts are turned in undesired directions; desire for work is turned into dislike. These mental effects must above all interest the psychological instructor. What is the use of prolonging instruction if the pupils during the last ten or fifteen minutes have ceased to be able to comprehend things? The question arises at once: By what means can we avoid fatigue, and how can fatigue be recognized and dealt with? Among other things, the length and occupation of recess are to be considered.

We are still considering the sensory, motor, and vaso-motor effect of fatigue. Here we find that which above all draws the attention of the social hygienist, namely, its deleterious influence upon the nervous system. It is evident that the health of the pupils must suffer if they do not sufficiently recuperate from that fatigue which cannot be separated from instruction. The statistics of school-diseases have spoken here in such distinct and warning tone that physicians have for some time studied the question of fatigue. Kraepelin,⁵ the specialist for nervous diseases in Heidelberg, has treated this subject and has raised it to a special branch of psycho-physical study. We have to thank him for the proof that the only really effective means for restoring strength lost by fatigue is a long and full sleep at night. Not food, not walking and diversions, not play or change of work,

⁵ Kraepelin, *Psychologische Arbeiten*.

form the factors which actually renew strength but only sleep, or at least absolute rest. But what happens to school children, especially in the higher schools? After the mental effort in school a large amount of home-work is often assigned. This work is imposed upon an already fatigued pupil. The next morning the boy is taught again from early morning on; he has to get up before sleep, the only effective means of recuperation, has accomplished its work. The boy comes to school still nervously exhausted; and now instruction begins again to whip up his psychical energy and to drain his nervous force. This goes on and on, so that Kraepelin has been able to assert, that the greater number of school children find themselves during a school-day in a continual narcosis of fatigue. No wonder that the health of the pupils so often suffers. Anaemia, loss of appetite, headache, and other "school diseases" appear.

A reasonable pedagogical hygiene must give the children a full night's sleep. In the German "Landerziehungsheim" at Ilsenburg, for instance, the younger pupils are given eleven hours of sleep. On the whole, it seems to work better if we prolong the morning sleep of the pupils instead of having them go to bed early in the evening. At least in the case of the pedagogical students in Karlsruhe the state of psychical energy in the morning rose at once, when from September on they went to bed an hour later and rose an hour later. It is easily seen that it is doubtful whether early morning instruction is wholesome. It is certain that 2 o'clock is too early for the afternoon. In the experiments of Wagner, a pupil of Kraepelin, most pupils (84 per cent.) show no recuperation even at 4 o'clock, three hours after the close of their forenoon instruction. So exhausting is forenoon instruction continued up to 1 o'clock. We ought to shorten it, therefore, and instead use the later afternoon between 4 and 6, or 5 and 7, for the purposes of the school. Here the state of energy is in itself much more favorable, and a prolonged intermission is put between the forenoon and afternoon teaching. But what about the time which the pupil needs for his home-work? The next article will answer this question.